1,009,425

PATENT SPECIFICATION

NO DRAWINGS

1,009,425

Inventors: PETER ROBERT MARSHALL, PHILIP JAMES RIDOUT and MICHAEL THOMAS MATTY

Date of filing Complete Specification: Dec. 7, 1962.

Application Date: Nov. 30, 1961. No. 42821/61.

Complete Specification Published: Nov. 10, 1965.

Index at acceptance:—C7 A(71X, A25Y, A27X, A28X, A28Y, A30Y, A31X, A33Y, A34Y, A35Y, A37Y, A38X, A39Y, A41Y, A43X, A44Y, A45X, A48Y, A50X, A51Y, A52X, A53Y, A54X, A55Y, A56X, A57Y, A58Y, A59X, A61Y, A62X, A67X, A68X, A69X, A70X, A70Y, A249, A266, A269, A272, A276, A279, A307, A309, A311, A313, A316, A319, A320, A323, 326, A330, A337, A339, A340, A341, A343, A345, A347, A349, A360, A362, A364, A377, A379, A381, A383, A385, A387, A389, A402, A404, A406, A409, A425, A428, A432, A435, A437, A439, A451, A453, A455, A457, A459, A499, A501, A503, A505, A507, A509, A521, A523, A525, A527, A529, A533, A535, A537, A539, A541, A557, A559, A562, A565, A568, A571, A574, A577, A579, A587, A589, A591, A593, A595, A609, A617, A619, A621, A623, A625, A627, A629, A671, A673, A674, A675, A677, A679, A681, A683, A684, A685, A687, A689, A693, A695, A696, A697, A699)

Int. Cl.:—C 22 c

COMPLETE SPECIFICATION

Improvements in or relating to Metal Powders and Articles Produced Therefrom

We, THE BIRMINGHAM SMALL ARMS COMPANY LIMITED, of Armoury Road, Small Heath, Birmingham 11, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to mixtures of metal powders of the kind having a ferrous composition, from which steel articles may be made by the processes of powder metallurgy.

One of the objects of the invention is to produce such steel articles having improved tensile strength without undue loss of ductility.

The manufacture of steel articles by powder metallurgical methods is usually commenced by mixing together individual powders in the correct proportions to achieve the composition desired, although it is known to use powders formed from steel of the desired composition, itself made by normal melting methods. It has been found that, generally speaking, considerably better mechanical properties are obtained by the former method, and it is with this method that the invention is concerned. The individual powders may be of elemental metals, alloys of two or more, but not all, the metals desired in the steel to be produced, or compounds of the metals. Ferro-compounds are frequently used.

According to the present invention there is provided a mixture of powders from which steel articles may be made by the processes of powder metallurgy, the alloying element content of which comprises the following, the percentages being by weight.

Nickel	1—4.9%
Manganese	0.1—2%
Molybdenum	0.1—5%
Carbon (Graphite)	0.1—1%

the remainder being iron plus the usual impurities.

The following are preferred more restricted ranges, any one or more of which may be substituted for the corresponding element in the wider ranges given above:—

Nickel	2—4.9%
Manganese	0.1—1%
Molybdenum	0.1—2%

A small portion of the iron content may be replaced by the same weight of one of more other elements which do not adversely affect the tensile strength and ductility of the articles produced from the powders. The amount of iron so replaced does not exceed 5% of the total weight of the mixture. The following is a list of elements which may be added, the figures in brackets indicating the upper

limit: Al(1%), B(0.3%), Cr(5%), Cu(5%), Mg(1%), Nb and/or Ta(4%), P(0.3%), Si(1%), Ti(1%), W(4%), V(0.3%), Zr(0.6%), Se(0.6%), Pb(0.5%).

The nickel is preferably added in the form of fine powder, preferably fine carbonyl nickel powder which usually has a particle size up to about 10 microns. The manganese may be added in the form of ferro-manganese powder and is preferably about 300 mesh (i.e. will pass completely through a 300 mesh sieve of British Standard Specification (which has an aperture of 53 microns square) or as manganese carbonate powder. The molybdenum may be added in the form of ferro-molybdenum powder (preferably about 300 mesh). The iron powder is preferably soft-iron powder and is preferably such that it will pass completely through a 100 mesh sieve of British Standard Specification (which has an aperature of 152 microns square), 75% will pass through a 200 mesh sieve of British Standard Specification (which has an aperature of 76 microns square) and 50% will pass through a 300 mesh British Standard Specification sieve.

Alternatively two or more of the alloying elements may be added to the iron powder in the form of a pre-alloyed powder preferably of such a particle size that it will pass completely through a 300 mesh (B.S.S.) sieve.

For producing a steel article, the powders are weighed in the desired proportions, and thoroughly mixed to produce a homogeneous mixture. At this stage lubricants such as paraffin wax, stearates, or other lubricants well known in the art may be incorporated in the desirable proportions. The mixture is then placed in a mould of the desired shape of the article to be produced, and is compacted under a pressure preferably of at least 20 tons per square inch. The compacted powder is ejected from the mould cavity and is then heated, in an atmosphere that prevents oxidation, at a temperature preferably between 1200°C and 1400°C for a time sufficient to enable sintering to take place. Preferably the time is at least 30 minutes. It will be appreciated that somewhat lower pressures and/or temperatures, and/or shorter times may be used and can give products which, whilst having somewhat inferior properties, may be acceptable for certain purposes, but the limits mentioned are the lowest generally acceptable. An example of a suitable non-oxidising atmosphere is a mixture of 75% hydrogen and 25% nitrogen.

As examples of the enhanced mechanical properties obtained by the invention, the following shows in tabular form the tensile strengths and elongation of a number of products produced by compacting the powder mixture at 35 t.s.i. and sintering for 1 hour at 1300°C.

Mix No.	Percentage Composition						
	Ni	Mn	Mo	Carbon (Graphite)	Iron and Impurities	Tensile strength tons/sq. in.	Elongation %
1	2.0	0.5	0.5	0.9	remainder	47.1	3
2	4.9	0.5	2.0	0.3	„	54.4	3
3	4.9	0.5	1.0	0.6	„	79.0	3
4	4.9	0.5	2.0	0.9	„	74.0	3

These properties may be compared with those given in our Co-pending Appln. No. 3522/59 Specification No. 931,961 which are obtained by the use of very much greater alloy contents than are necessary under the present invention.

After the compacting and sintering operations, the powder compacts may be coined at pressures up to 60 tons per square inch to give increased strength and toughness or greater accuracy in dimensions. The coined compacts may also be given a further sintering at a temperature up to 1400°C in a suitable atmosphere.

The sintered or coined compacts may be heat-treated by normal methods as applied to wrought steel, and they may, by the usual methods, be case-hardened, electro-plated, phosphatised or provided with a coating of chromium which is diffused into the article.

WHAT WE CLAIM IS:—

1. A mixture of powders from which steel articles may be made by the processes of powder metallurgy, the alloying element content of which comprises the following, the percentages being by weight:—

Nickel	1—4.9%
Manganese	0.1—2%
Molybdenum	0.1—5%
Carbon (Graphite)	0.1—1%

the remainder being iron plus the usual impurities.

2. A mixture according to Claim 1 in which any one or more of the following ranges of elements is or are substituted for the corresponding range or ranges of the element or elements specified in that claim:—

Nickel	2—4.9%
Manganese	0.1—1%
Molybdenum	0.1—2%

3. A mixture according to Claim 1 or Claim 2 wherein manganese is included as the appropriate weight of manganese carbonate.

4. A mixture according to any of Claims 1 to 3, wherein up to 5% of the iron content is replaced by an equal weight of a powder consisting of one or more additional element or elements in a maximum percentage by weight as follows:—Aluminium 1%, Boron 0.3%, Chromium 5%, Copper 5%, Magnesium 1%, Niobium and/or Tantalum 4%, Phosphorus 0.3%, Silicon 1%, Titanium 2%, Tungsten 4%, Vanadium 0.3%, Zirconium 0.6%, Selenium 0.6% and Lead 0.5%.

5. A mixture of powders from which steel articles may be made by the processes of powder metallurgy, the alloying element content of which comprises the following, the percentages being by weight:—

Nickel	2%
Manganese	0.5%
Molybdenum	0.5%
Carbon (Graphite)	0.9%

the remainder being iron plus the usual impurities.

6. A mixture of powders from which steel articles may be made by the processes of powder metallurgy, the alloying element content of which comprises the following, the percentages being by weight:—

Nickel	4.9%
Manganese	0.5%
Molybdenum	2.0%
Carbon (Graphite)	0.3%

the remainder being iron plus the usual impurities.

7. A mixture of powders from which steel articles may be made by the processes of powder metallurgy, the alloying element content of which comprises the following, the percentages being by weight:—

Nickel	4.9%
Manganese	0.5%
Molybdenum	1.0%
Carbon (Graphite)	0.6%

the remainder being iron plus the usual impurities.

8. A mixture of powders from which steel articles may be made by the processes of powder metallurgy, the alloying element content of which comprises the following, the percentages being by weight:—

Nickel	4.9%
Manganese	0.5%
Molybdenum	2.0%
Carbon (Graphite)	0.9%

the remainder being iron plus the usual impurities.

9. A mixture according to any preceding claim, wherein any one or more of the powders is an alloy of two or more of the alloying elements.

10. A mixture according to any preceding Claim wherein the ferro-alloy particles other than iron powder are such as to pass through a 300 mesh sieve of British Standard Specification (which has an aperture 53 microns square).

11. A mixture according to Claim 10, wherein the iron powder is such that it will pass completely through a 100 mesh sieve of British Standard Specification (which has an aperture of 152 microns square), that 75% of it will pass through a 200 mesh sieve of British Standard Specification (which has an aperture of 76 microns square), and 50% of it will pass through a 300 mesh sieve of British Standard Specification.

12. A steel article manufactured from a mixture according to any preceding Claim by powder metallurgy.

13. A method of manufacture of a steel article from a mixture according to any of Claims 1 to 11 comprising the steps of pressing the mixture to the desired shape under a pressure of at least 20 tons per square inch, ejecting the pressed compact from the mould and then heating it in a non-oxidising atmosphere at a temperature between 1200°C and 1400°C for at least 30 minutes.

14. A method according to Claim 13 wherein the mixture is pressed under a pressure of 35 tons per square inch and heated for 1 hour at a temperature of 1300°C.

15. A method according to Claim 13 or

Claim 14 wherein the non-oxidising atmosphere comprises approximately 75% hydrogen and 25% nitrogen.

16. A steel article manufactured by the mehod according to any of Claims 13 to 15.

NORMAN H. BUCKLEY,
Chartered Patent Agent,
Agent for Applicants.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1965. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.